Fabrication of Bio Composite Pipes Using Bamboo Fibre

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Abstract - Composite materials are one of the major developments in material technology in which the chief constituents are reinforcement and matrix. The current trend is to use the bio- degradable reinforcement like bamboo, jute, cotton and hemp etc., are greatly elongated substances produced by plant. Such natural fiber based composite materials have different applications. The objective of the present work is to fabricate the short bamboo fiber composite (SBFC) pipe as per ASTM standards using epoxy as matrix and studding the mechanical properties with conventional materials. By using epoxy and hardner with a certain ratios by mixing with short bamboo fibre. By prepaing the mould as per the ASTM standards and fill the mixed bamboo fibre hardner and epoxy in the mould and leave it for two to three days and the process is done by using ramming the mixed material into the mould. Using the releasing agent we have to remove the pipe from the mould and fabrication should be done to get finished product. Test the product with different types of tests known as Torsion test to know the twisting moment of the product, SEM Test is use to see the structure and behavior of the product , moisture content test to know the absorption of the liquid it can withstand the pressure . Three point bending test is done for the strength of the material. At last compare all the test reports with the conventional pipe (PVC).

Keywords: Short bamboo fiber, epoxy resin, pipe, SEM, tensile test, compression test, bending test.

1 INTRODUCTION

The natural fiber reinforced composites (NFRC) are rapidly replacing petroleum based composites in different areas such as automotive, electrical construction and even building industries due to low-density materials yielding relatively light weight composites with high specific properties One of the main important aspects of the behavior of NFRC is their response to an bending load and the capacity of the composites to withstand it during their service life. Some of the reported work has suggested that NFRC are very sensitive to impact loading [1]. The bamboo tree belongs to a group of woody perennial evergreen plants in the true grass family Phocaea, subfamily Bambusoideae, tribe Bambuseae.

It is one of the fastest growing woody plants in the world. This is perhaps due to their unique rhizome system and is dependent on local soil and climate conditions. They are of economic and high cultural significance in East Asia and South East Asia where they are used extensively in gardens as building material as well as food source. In Nigeria, they are used for building supports and tooth picks. While wood has a hard center and becomes weaker toward the outer part, bamboo is hard in its outer, while weak in its inner parts, this leads to a much more stable construction. The more stable fiber structures are most dense where you find the highest stress. Accordingly, the adoption of bamboo fiber in composite application, especially in low strength areas will be most desirable. As a fiber, the overall mechanical properties of bamboo are comparable to or even better than those of wood. Moreover, the specific gravity of bamboo is relatively high when compared to the hardwoods or heavy tropical timber species which are normally used in composites panels manufacturing[6]. Thus, it should be used for the high-density composite products such as High-Density Fiber board.

These advantages make it highly competitive nature fiber reinforcement in polymer composites. Bamboo is one of the woody plants that always gain most manufacturers' attention due to several advantages such as ease of growth in diverse climates which make it durability and low-cost material when compared to others. Even though bamboo is one of the old and traditional building materials, it is actively being practiced until today. Bamboos are abundantly growing mainly in South America and Asia, including Malaysia.

It is one of the oldest materials used by mankind the culms or stem of bamboo has been made into diverse products ranging from domestic household items to industrial products. Bamboo has been used as chief load bearing element in houses, bicycles, windmills and retaining walls to name only a few. Bamboo is a biomass resource which is available plentifully in India, china and many countries of South America. In India, 130 species of bamboo spread across 18 genera grows on millions of hectares of forest land, in homesteads and on private plantations. Apart from being one of the

fastest growing plants with a short maturity cycle of 3-4 years, so that harvest time can be short, bamboo has such attractive features as high specific strength and modulus, low density and as a natural material its degradability. In many densely populated regions of the tropics, certain bamboos supply the one suitable material that is sufficiently cheap and plentiful to meet the extensive need for economical; these composites have high strength to weight ratio, durability, and dimensional stability, to be engineered to any complex shape or size and above all lower the cost of production. Among the various biomass sources, bamboo is one of the most rapidly generating resources. Bamboo has been processed into composites as a wood substitute and replaced timber in many applications such as doors & windows and their frames, partitions, wardrobes, cabinets, flooring, furniture etc. Over the last two decades bamboo-resin composites have been increasingly explored as a material in the construction industry because the tensile, compressive and bending strength of the composites is superior to that of both the natural material as well as resin component in the composite. Use of resin prevents cracking and deformation under high relative humidity. Also, bamboo-resin composites show higher resistance to insect pest bio-erosion. Detailed research studies on mechanical properties of bamboo polymer laminates are few. Therefore, there is need to characterize bamboo-based laminates for mechanical properties including tensile strength, compressive strength and flexural strength, so that the full potential of bamboo as an engineering material could be realized. One of the objectives of this research is to explore the mechanical properties of bamboo-polymer laminates to be used as an environment friendly material in the construction sector. The demand placed on materials for better overall performance is so great and diverse that no one material can satisfy them. Natural fibres are now regarded as a serious alternative to glass fibre for use as reinforcements in composite materials. Their advantages include low-cost, low density, high strength-to-weight ratio, and resistance to breakage during processing, low energy content and recyclability. The properties of natural fibre-based composites can be affected.

2 Literature review

1. Pankaj Tripathi, Kuldeep Yadav (May -2017) that the tensile and flexural properties of bamboo/glass fibre hybrid composite is suitable for highly flexibility & it can be concluded by finding such a value of tensile & flexural strength that the mechanical properties significantly influenced while using bamboo & glass fibre in such layer manner.

2. Dipika Devi, Boken Jempen (Aug-2016) the shear parameters of soil with and without bamboo fibre are compared. The length of fibre also cause increase in shear strength of the soil.

3. S. A. H. Roslan, Z. A. Rasid and M. Z. Hassan (Aug2015) the tensile properties of laminated composite, while the mechanical properties are compared with the mechanical properties of natural fiber.

4. Hingujam Jackson Sing, Sutanu Samanta (May-2014) the natural fiber reinforced composites got high potential of replacing the conventional material used in the electrical appliances. Research works regarding the use of natural fiber composites as the electrical resistance are also reported. Only very few research works on the machining optimizations of the natural composite materials have been reported.

5. Y. Cai, B. Shi, C. W. Ng and C. S. Tang (2006) compared the fatigue behaviour under cyclic tensile load and the hydro thermal ageing of Bamboo fibre reinforced polypropylene (BFRP) and bamboo- Glass fibre reinforced polypropylene (BGRP). The results showed that although the tensile strength of BFRP is slightly lower than that of the PP samples, enhancement is found by inclusion of glass fibre with 3 % MAPP. It also showed that the BGRP has better fatigue resistance than the BFRP composites at all load levels. Thus, it shows the improvement in the mechanical properties due to hybridization. Okubo (2004) using steam explosion technique to extract bamboo fibres and study a typical tensile stress –strain curve and the tensile strength distribution of improved bamboo fibre eco- composite BFEC and bamboo fibre cotton eco- composite BFcEC. The result show that the tensile strength and young modulus of the BFcEC increased from 15 to 390% respectively.

6. Pankaj Tripathi, Kuldeep Yadav (May -2017) that the tensile and flexural properties of bamboo fiber hybrid composite is suitable for highly flexibility & it can be concluded by finding such a value of tensile & flexural strength that the mechanical properties significantly influenced while using bamboo fiber in such layer manner.

7. S. A. H. Roslan, Z. A. Rasid and M. Z. Hassan (Aug2015) the tensile properties of laminated composite, while the mechanical properties are compared with the mechanical properties of natural fiber.

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3 Methodology

Four-year-old green bamboo culms were obtained. The moisture content of as collected green bamboo was in

the range 37- 42% at the time. The moisture content was reduced to 10-12% by sun drying so that better adhesion of the laminates could be achieved.

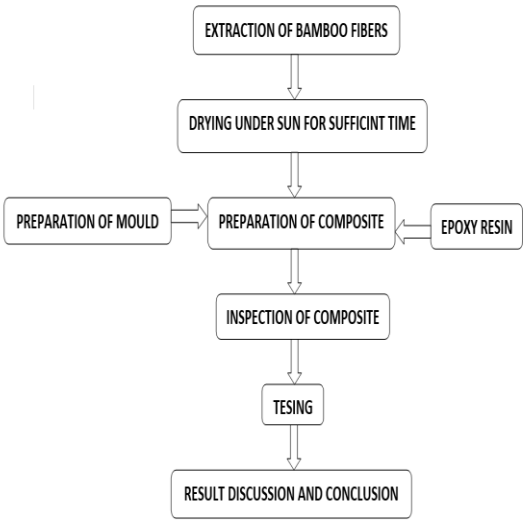

Fig 1: Methodology

A full-length bamboo was cut length-wise into many slats using sharp cutter. hacksaw respectively for outer, middle and inner regions. To evaluate mechanical properties using a Universal Testing Machines. One sample were prepared from each location for obtaining average of test results for all type of loading conditions. The dimensions of bamboo laminae were made uniform by using medium fine sandpaper. Since the width of laminas prepared from the outer region of bamboo culms was less owing to the circular cross section, these laminas were butt joined using adhesive to make laminates with larger width. Then we prepared an bamboo Skelton to develop cylindrical shape by using an hard internal mould to lock the bamboos. The next step is to mix the epoxy as required quantity or required ratio. Next step is to pour the epoxy resin using different kind of moulding such as injection moulding gravity moulding or centrifugal moulding. After the moulding process is curing for hardening of epoxy resin and form solid structure. Furner testing the tensile, compressive and bending load for bamboo composite material.

4 Extraction of bamboo fibre

Fig2:Long bamboo fiber

Fig3: Short bamboo fiber

Soaking the bamboo straps under water for 72 hours to reduce bonding between the bamboo fibre. Hammering the long bamboo strap to extract long bamboo fibre. And finally, the long fibre will be dried and will be cut into short pieces and this short fibre will be ready for use.

5 FABRICATION OF BIO-COMPOSITE PIPE USING BAMBOO FIBER

Modified by a number of factors such as fibre combinations, processing method, fibre volume fraction, aspect ratio, water absorption, etc. The fabrication method has a significant impact on the resulting properties. Various processing methods, e.g. compression melding, injection moulding, extrusion moulding, and hand lay-up, are available for natural fibre composite materials. Injection moulding improves the fibre dispersion, hence increasing the tensile and flexural properties.

Fig4: Short bamboo fiber

However, extrusion and injection moulding have detrimental effects on the properties of natural fibres. Bamboo can be used for reinforcement such as the whole bamboo, section, strips and the fibres. These various forms of bamboo have been used in applications such as low-rise construction to resist earthquake and wind loads, bamboo mats composite in combination with wood for beam, and shear wall in low rise construction in addition bamboo fibre can be used as reinforcement with various thermoplastic and thermo set polymer. They have high specific properties such as stiffness, impact resistance, flexibility and modulus, and are comparable to those of glass fibre. Bamboo can be used for reinforcement such as the whole bamboo, section, strips and the fibres. These various forms of bamboo have been used in applications such as low-rise construction to resist earthquake and wind loads, bamboo mats composite in combination with wood for beam, and shear wall in low rise construction in addi-

tion bamboo fibre can be used as reinforcement with various thermoplastic and thermo set polymer.

6 Results and Discussions

The project has been completed 80%, so we couldn't do the required tests. And the work we did is, designing of the pipe by using the bamboo fibre by extrusion process. The left-out part was, testing the material which is needed to compare with the conventional pipe (PVC).

7 Conclusion

Extracted shot bamboo fibers and fabricated biodegradable bamboo composite pipe with uniform wall thickness. By doing this project we have gained good knowledge about natural fibers and the mechanical tests were conducted and results were discussed. By seeing the test results, we here by conclude that the bamboo fiber with epoxy composite has achieved better result as per our result.

8 Scope for Future Studies

Composite pipe use has been established in flow line, gathering line, and distribution systems associated with natural gas transmission. Flow line and gathering line systems share common barriers, but they are for the most part being adequately addressed by industry. By far, the biggest technology challenge is finding stronger, less expensive, and longer lasting pipeline materials for large diameter and high-pressure/high-volume transmission fluid systems. The barriers to using composite in tubular and transmission lines are both financial, technology and perception based. Current resin/fiber-based composite pipe is far more expensive than steel in the sizes need especially for transmission lines. However, FRP are being looked at because of their superior corrosion resistance and high strength-to-weight ratio. Experimental results show that only AR-glass has the strong corrosion resistance. The other three are moderately corrosion resistant. Therefore, it is also necessary to look back FRP materials for further improvement.

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